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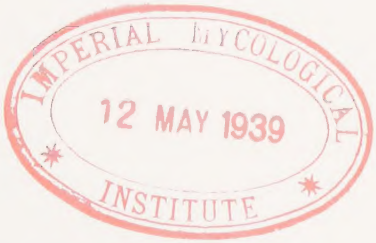
GRAPE DISEASE CONTROL IN DELAWARE

By

T. F. MANNS



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SUMMARY WITH RECOMMENDATIONS

Five years of grape spraying experiments and demonstrations in Delaware have brought out the following points:

1—Grape diseases are carried from season to season on the wood tied up; this is true for black rot, anthracnose, bitter rot, dead arm, and ripe rot. This source of infection on the new wood is known as the "carry-over".

2—Spraying demonstrations in 1924 showed that this "carry-over" infection takes place on the new growth, on the first seven or eight internodes, before the growth is five inches long.

3—The delayed dormant spray, applied when the new growth was one-half to three-fourths inches out, prevented the "carry-over" infection; however, a spray, applied when the growth was 5 to 7 inches out failed to control the "carry-over". The delayed dormant spray must be included in the spray program if the source of disease infection is to be eliminated.

4—Black rot dissemination was heaviest, four seasons out of five, during the blossoming period; if the preblossom spray was omitted the disease could not be controlled on the fruit. Galloway working in Virginia in 1890, and Selby, in Ohio in 1900, called attention to these important facts, but they have been overlooked.

5—A Bordeaux spray applied just before blossoming is efficient in preventing black rot infection during the blossoming period. The after-blossom spray was effective in controlling black rot in 1926 when drouth prevailed till after blossoming.

6—Arsenate of lead in the preblossom spray in 1926 greatly assisted in checking the work of the berry moth.

7—The five spray program (See page 36) controls black rot, anthracnose, bitter rot, dead arm, and ripe rot on the varieties, Concord and Moore's Early. A late application may be needed in certain seasons for control of downy mildew.

8—A timely and efficient spraying program is required to control and eliminate grape diseases. (See page 34)

GRAPE DISEASE CONTROL IN DELAWARE

T. F. MANNS

INTRODUCTION

Observations on grape disease control in Delaware for a number of years have shown that grape growers who made *two or three early*, or preblossom sprays, were much more successful in controlling black rot and other diseases than those who made six, or even more, afterblossom sprays. Experimental and demonstrational work, in grape spraying in Delaware during the past five years, has also brought out the value of the preblossom sprays, not only for black rot control, but for other grape diseases.

The value of the earlier sprays for black rot control was brought out by both Scribner and Galloway as early as 1891 and 1892. Scribner (1),* in reviewing his experiments on black rot writes, "one of the chief points learned was that we must begin the battle very early in the season, if we would secure the victory."

Galloway (2), gave very important data on the value of the early sprays as compared with the late sprays in the control of black rot. His work, done at Sterling, Virginia, shows that four early sprays (three preblossom and one directly after blossom) were much superior to three late sprays. (The first directly after blossoming and the second, two weeks later and the third, two weeks after the second.)

His data show (See Table I) that the four early sprays produced 90% perfect fruit while the three afterblossom sprays with the same strength of Bordeaux produced only 11% perfect fruit on one plot. Dr. Galloway worked with two strengths of Bordeaux. What he calls his "half-strength" is somewhat stronger than 6-4-50 formula. His formula was copper sulfate 3 lbs., lime (unslacked) 2 lbs. and water 22 gallons; this when doubled becomes a 6-4-44 formula. The data for his "half-strength" sprays were as follows:

TABLE I

Data From Galloway's Spraying Work in 1892 at Sterling, Va.

Number of Sprays	Percent of Perfect Fruit
6 Early sprays—three preblassom, and three afterblossom.	93%
4 Early sprays—three preblossom, and one afterblossom.	90%
3 Late sprays—all afterblossom	11%
3 Late sprays—all afterblossom	16%
Unsprayed (5 plots)	0%
Unsprayed (3 plots)	4.54%, 3%, and .98% respectively

* Numbers in parentheses refer to bibliography on page 36.

In conclusion, he says, "In every case early treatments gave decidedly better results *than late* ones". . . ."Six treatments, the last two after the grapes were practically grown, gave little better results than four, the last being made when the berries were the size of bird shot."

Selby (3), of the Ohio Experiment Station, also showed the value of the preblossom sprays for black rot, especially the spray just preceding the blossoming period. In a program in which he used three preblossom sprays and five afterblossom sprays, when he omitted the one spray just before blossoming, the yield of marketable grapes was reduced from 103 baskets to only 10 baskets per row. When he omitted the spray just after blossoming, the yield was 100 baskets. In his summary Selby concluded, "the omission of the spray upon the young shoots just before blossoming showed as a result a loss of 90% from black rot. Omission of the earlier, or of the next later spraying, showed no decided losses." This work shows the spray just before blossoming is much more important than the one right after blossoming as far as black rot of fruit is concerned.

The findings of the Delaware Station during the past five years have run parallel with those of Scribner, Galloway and Selby with one exception, the season of 1926, when drought prevailed till after blossoming, a condition that prevented the early dissemination of black rot.

FIG. 1.—Properly sprayed fruit is free from fungous and insect troubles. The fruit in the illustration came from a well sprayed twenty acre Concord Vineyard which averaged nearly five tons to the acre.

Acknowledgments

Much credit is due the cooperators whose work has made possible the demonstrations and experiments during the past five years; to Messrs. S. J. Hall, N. W. Taylor, Alfred R. Smith, Ralph Spruance and George Carter in whose vineyards the demonstrations and experiments were conducted; to the members of the Farm Bureau Committee on Grapes, Mr. Ed. William, Chairman, who have assisted greatly in furthering the work; and to County Agents, Alex D. Cobb and Russell E. Wilson, who assisted in laying out the experiments, applying the sprays and gathering the data.

Grape Spraying Demonstrations of 1922

In 1922, demonstration plots for spraying work were laid out at the vineyard of Mr. Hall, one mile north of Dover. It was planned to compare the set-arm method of spraying with four nozzles on each arm (traction outfit) with the "trailer method," having two lines of hose and two nozzles to each lead. The following "five spray" program was planned:

Spray No. 1—Delayed dormant, growth ½ to¾ inch.
Spray No. 2—Growth 6 to 8 inches.
Spray No. 3—Preblossom, growth 12 to 18 inches.
Spray No. 4—Immediately after blossom.
Spray No. 5—Grapes size of peas.

The Importance of the Delayed Dormant and the Preblossom Sprays

The first, or delayed dormant, spray was planned for April 26; however, the sprayer was out of order and repairs were not made until May 9th. On this date, the first spray was applied; the growth was 9 to 12 inches long. A thorough application of a 3-5-50 Bordeaux was made on each of the plots, using the set-arms on one plot and the trailer system on the other plot.

The preblossom spray was planned for May 23rd; at that time the tenant was making fertilizer applications and asked to postpone the spraying till the day following; then rain interfered; four trips were made but rains made it impossible to spray till after June 6th. The grapes had rapidly gone through the blossoming period. On June the 9th, the second spray was applied; the grapes were then the size of duck shot. Infection with black rot in the way of "carry-over" spots could be observed along the internodes of the new vine growth for a distance of six to ten inches. The cluster parts showed beginning lesions. Inspection of the fruit, even at this young stage, showed the beginning of infection and disturbance about the lenticels, although no rot was present.

Third Spray—On date of June 23, the third spray was applied and a very thorough application was given. The grapes were the size of

large peas. Heavy infection of the fruit was showing, not only on the unsprayed plots, but also to some extent on both of the sprayed plots. *The failure to control infection of the fruit was due to missing the pre-blossom spray.*

Fourth Spray—On July 8, the fourth spray was applied. Infection with black rot was general. Estimate showed that 10% of the grapes were already rotting on the sprayed plots, and 35 to 40% on the unsprayed plots. The spraying machine worked very poorly on this occasion; it failed to maintain a pressure of 30 to 40 lbs. and a thorough job was impossible, even by going over the plots twice.

The amount of rot was so great on July 15 that the fifth spray was omitted. The black rot had developed so rapidly that there was no evidence of the late sprays being of any value.

Through a misunderstanding, opportunity was not given to get the data on the sprayed plots. Estimates indicated the sprayed plots were about 50% rotted, and the unsprayed about 80 per cent.

FIG. 2.—Showing the work of black rot on the unsprayed plots in 1922. More than 80% of the grapes rotted. Black rot is the most serious grape disease in Delaware. The most effective sprays are, (1) the "delayed dormant" spray which prevents the carry-over on the new wood; (2) when the growth is 5 to 8 inches out; (3) the "preblossom"; (4) the "afterblossom" and (5) the "size of peas" spray. Later sprays have shown little value in the control of this disease.

GRAPE SPRAYING DEMONSTRATIONS IN 1923

In planning the work for this year, greater emphasis was again placed upon the value of the preblossom sprays. The spraying program was the same as outlined for 1922, that is, *three preblossom sprays* and *two afterblossom sprays*. It was planned to enlarge the demonstrations in order to show the value of the preblossom sprays as compared

with the afterblossom sprays. Accordingly, five plots were laid out as follows:

TABLE II

Plan of Spraying Demonstrations at Hall's Vineyard Near Dover in 1923

Time of Spray	Plot 1 5 sprays	Plot 2 4 sprays	Plot 3 4 sprays	Plot 4 3 sprays	Plot 5 2 sprays	Plot 6 Unspr'y'd
1-Delayed Dormant (4/27)	X*	X	O	O	O	O
2-Growth 6-8 Inches (5/8)	X	X	X	X	O	O
3-Preblossom (5/22)	X	X	X	X	O	O
4-Afterblossom (6/12)	X	X	X	X	X	O
5-Size of Peas (6/26)	X	O	X	O	X	O

*(X)=Sprayed (O)=Spray omitted

The sprays on the several plots were applied as outlined in the above table. A two-wheeled power truck outfit was used this season.

Dates of Spraying and Weather Conditions in 1923

The first, or delayed dormant spray, was applied April 24 on Plots 1 and 2. A pressure of 175 pounds was used which covered well, in spite of wind. The trailer method was followed, using two nozzles per row. The developing shoots were about ½ to ¾ of an inch out. The weather was cold, windy, and dry. A 6-6-50 Bordeaux spray was used.

The second spray (growth 6 to 8 inches) was applied May 8. The blossom clusters were showing nicely. Vines appeared very healthy. The weather was cold, and had been cold for the previous two weeks. The growth was quite backward. The pressure used was 150 to 175 lbs. The application, a 3-6-50 Bordeaux, went on fine, although the wind was very strong. The spray was applied on Plots 1, 2, 3, and 4.

The third spray, or (preblossom spray), was applied May 22 on Plots 1, 2, 3, and 4. The sprayer worked well at a pressure of 175 to 200 lbs. The weather was favorable; the ground was very dry; little or no rain had fallen. The first black rot was observed as a leaf infection on this date. A 3-6-50 Bordeaux was used.

The fourth spray or afterblossom spray was applied June 12 on Plots 1, 2, 3, 4, and 5. The ground was very dry, no rain having fallen for weeks. The pressure was 175 to 200 lbs. Two pounds of powdered arsenate of lead were used to 100 gallons of spray and a 3-6-50 Bordeaux formula was used.

The fifth spray, or "size of peas" spray was applied June 26 on Plots 1, 3, and 5. At this time, there were traces of black rot on the fruit in all the Plots, but it was most severe on the unsprayed plot. In this spray, powdered arsenate of lead was used at the rate of two pounds to 100 gallons of spray; the Bordeaux was 3-6-50; the weather was fine; no rain had fallen for two months and the land was too hard to plow.

Amount of Disease Estimated

The very dry weather during May, June, and July was a great

factor in checking the prevalence of black rot. On the date of September 5, a careful estimate of the amount of black rot on each of the plots was made as follows:

Plot 1-5 sprays; amount of black rot, less than 0.1%
Plot 2-4 sprays; amount of black rot, less than 1.0%
Plot 3-4 sprays; amount of black rot, less than 1.0%
Plot 4-3 sprays; amount of black rot, less than 1.0%
Plot 5-2 sprays; amount of black rot, less than 5.0%
Plot 6- Unsprayed; amount of black rot, less than 18.0%

FIG 3.—Showing the nature of black rot lesions on the foliage. Our studies indicate that leaf infection is not as important as vine infection in carrying-over the disease from year to year. The important "carry-over" vine infection takes place when new growth is one to four inches long. Leaf infection may take place later. (Photograph by Arthur S. Rhoads, Bul. 178, Fla. Sta.)

Arrangements were made to harvest the grapes on the sprayed plots on September 7; however, on this date, the cooperator, through a misunderstanding, had gathered the grapes from the several sprayed plots and had failed to keep the yields separate.

GRAPE SPRAYING DEMONSTRATIONS FOR 1924

Demonstrations were conducted at the vineyard of Mr. N. W. Taylor, one mile Southeast of Dover. Most of the evidence to date had indicated that the preblossom sprays were of the greatest importance, not only for black rot control, but for prevention of several other fungous diseases which infect the internodes of the first growth in the spring. Accordingly, the following scheme of spraying was planned, in which the dormant spray and "growth 6 to 8 inches" spray, were to be omitted on some of the plots and also the "size of peas" spray.

TABLE III

Plan of 1924 Spraying Work at N. W. Taylor's Vineyard

Spray	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
1—Dormant	X	X	O	O	O
2—Growth 6-8 inches	X	O	X	X	O
3—Preblossom	X	X	X	X	O
4—Extra preblossom*	X	X	X	O	O
5—Afterblossom	X	X	X	X	O
6—Size of Peas	X	X	X	O	O

(X) = Spray Applied (O) = Spray omitted

* Cold weather delaying blossoming made necessary this extra spray.

Dates of Applications and Weather Conditions

First Spray—The delayed domant spray was applied May 6 on Plots 1 and 2. It had rained every other day.

Second Spray—The "Growth 6 to 8 inches" Spray was applied May 15 on Plots 1, 3, and 4. It had rained every other day.

Third Spray—The preblossom spray was applied May 27 on Plots 1, 2, 3, and 4. A small amount of black rot was showing on the check. It had rained every other day.

Fourth Spray—An extra spray. On account of the long cool spring, it became necessary to put on an extra preblossom spray on *June* 13. This extra spray was applied on Plots 1, 2, and 3 and omitted on Plot 4. (At this time about 20% of the blossoms were out). It had rained every other day.

Fifth Spray—The regular *"afterblossom"* spray was applied June 24, putting the same on Plots 1, 2, 3, and 4. For the past seven weeks it had rained nearly every other day.

Sixth Spray —The "size of peas" spray was applied July 7. This spray was put on Plots 1, 2, and 3.

The Importance of the Delayed Dormant Spray Was Brought Out

To the best knowledge of the author, for the first time in the history of grape spraying, the work at Mr. Taylor's vineyard brought out the value of the delayed dormant spray in preventing and controlling the infection which becomes the "carry-over," on the new growth. The new growth on Plots 1 and 2 which received the delayed dormant spray, was practically free from any infection, whereas the new growth on Plots 3 and 4 which received no delayed dormant spray, but did receive the spray when the growth was five inches long, had heavy infection on the first five to eight internodes.

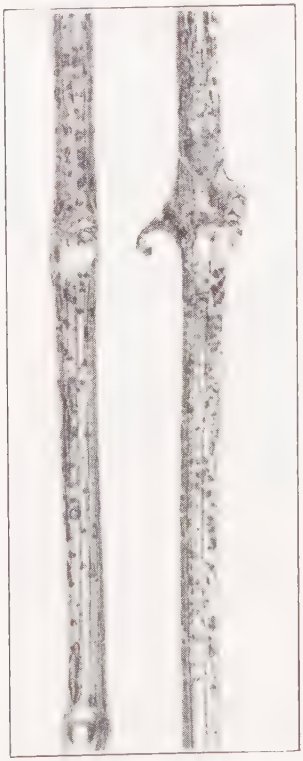

FIG. 4.—Black rot infection showing small lesions as they appear on the new wood at the end of the growing season. Such infections become the "carry-over", which spreads the disease the following season. Early sprays, including the "delayed dormant", when the new growth is not more than three fourths to one inch out, prevents this carry-over. (Photograph by Arthur S. Rhoads, Bul. 178, Fla. Exp. Sta.)

For several years there had been accumulating evidence that the infection on the internodes of the new growth was the chief means of carrying black rot (See Figures 4 and 6) and other diseases from season to season, rather than the infected foliage or "black rotted" fruit on

the ground. This information also pointed to the value of keeping the old "carry-over" wood and the new growth covered with spray during the period of black rot dissemination. The spores of practically all the early appearing grape diseases are disseminated by moisture. This includes black rot, anthracnose, bitter rot, dead arm, and the European ripe rot caused by *Pestalozzi uvicola*. These diseases are disseminated much earlier than we had heretofore estimated. The infection must take place when the new growth is from one to three inches out in order to show macroscopic lesions when the new growth is seven to nine inches long, which was the case this year (1924).

FIG. 5.—Blight of the blossom clusters caused by the black rot fungus. This type of trouble is not so severe on the Concord or Moore's early varieties in Delaware, but it causes some damage. The several pre-blossom sprays, with Bordeaux, prevent all cluster injury by fungous diseases. (Photograph by Arthur S. Rhoads, Bul. 178, Fla. Exp. Sta.)

It can now be understood why covering the old "carry-over" wood and the new growth with early sprays greatly assists in keeping down new infection and thus in controlling black rot and other diseases. (See Figures 4 and 6, pages 12 and 17)

Results of 1925 Demonstrations

The check, or unsprayed vines, showed only a very few black rotted berries, not more than a half dozen from the eight unsprayed

vines. There was, however, some evidence of cluster-shattering due to black rot; also there was evidence of weakening of the vine due to infection with "dead arm" on the unsprayed vines. The data from each of the plots when estimated on an acre basis were as follows:

TABLE IV

Showing Results at Mr. Taylor's Vineyard in 1924

Plot	Number of Sprays	Number of Vines	Total Weight of Grapes	Yield on Acre Basis
1	6	12	102.12 lbs.	2.55 Tons
2	5	12	133.69 lbs.	3.34 Tons
3	5	12	99.10 lbs.	2.48 Tons
4	3	12	113.94 lbs.	2.85 Tons
5	Not Sprayed	8	57.77 lbs.	2.14 Tons

The average yield per acre of the sprayed plots was 2.805 Tons. The average per cent increase of the sprayed over the unsprayed was 31.8%.

It was noted that there was great variation in the yields from adjacent rows; this was sometimes as high as 10 to 30 per cent. Plots 1 and 2 received the delayed dormant spray whereas Plots 3 and 4 had the dormant spray omitted. The total yield of Plots 1 and 2 was 235 lbs. and 13 oz. and the yield from Plots 3 and 4 was 213 lbs. and ½ oz. Thus the delayed dormant spray apparently increased the yield of Plots 1 and 2 more than 10% above Plots 3 and 4 which received no delayed dormant spray. It would require data from several years of experimental work to show clearly the value of the delayed dormant spray as a factor in increasing yield. *Much injury to the new growth from internodal infection has been noted, the control of which, it has been shown, can only take place by the application of the delayed dormant spray.* When the first spray is delayed until the growth is five to six inches out, it is then too late to control most of the "carry-over" infection.

Although there was little evidence of black rot in the unsprayed plots in 1924, the sprayed plots showed considerable increase in yield over the unsprayed.

Taking the yield of the unsprayed plot at 100%, then the increases in the sprayed plots over the unsprayed were as follows:

Plot 1—19.8% Increase
Plot 2—56.0% Increase
Plot 3—15.6% Increase
Plot 4—32.9% Increase

Much of the above irregularity in the yields of the several plots is due to natural fluctuations from row to row. To balance this irregularity in the yields of rows, the unsprayed vines were located equally on

row No. 2 (same row as Plot 2) and row No. 3 (same row as Plot 3); the increased yield of the sprayed over the unsprayed would indicate that it was not a matter of irregularity in yield, but a direct result of the spray.

SPRAYING AND DUSTING DEMONSTRATIONS FOR 1925

Spraying demonstrations differ from most other demonstration work, in that just as soon as a thorough spraying program has been applied to an orchard or vineyard, this particular orchard or vineyard is no longer suitable for a disease control demonstration, for the simple reason that the "carry-over", the real source of infection which brings general disease conditions, is no longer present. Hence, we must go elsewhere to find an orchard or vineyard carrying general infection.

Location of 1925 Demonstrations

The vineyard of Mr. Ralph Spruance of Smyrna, comprising about eight acres of Moore's Early and Concord, was a total loss in 1924 from black rot. Such heavy infection provided ideal conditions for spraying demonstrations. Accordingly the following spraying work was laid out on the Moore's Early.

TABLE V

1925 Plans of Spraying Work at Ralph Spruance's Vineyard at Smyrna

Time of Spray	Plot 1 5 sprays	Plot 2 4 sprays	Plot 3 3 sprays	Plot 4 2 sprays	Plot 5 Unsprayed
1—Delayed Dormant	X	O	O	O	O
2—Growth 5-8 inches	X	X	O	O	O
3—Preblossom	X	X	X	O	O
4—Afterblossom	X	X	X	X	O
5—Size of peas	X	X	X	X	O

(X) = Indicates spray was applied.
(O) = Indicates spray was omitted.

Dates When Sprays Were Applied

1. Delayed dormant—April 22—Plot 1
2. "Growth 5-8 inches"—May 6—Plots 1 and 2
3. Preblossom—May 27—Plots 1, 2, and 3; this spray was delayed 2 days by rains.
4. Afterblossom—June 12—Plots 1, 2, 3, and 4
5. Size of Peas—June 22—Plots 1, 2, 3 and 4

The success of the complete spraying program was very obvious. The clusters on the check, or unsprayed vines, were very badly shattered with black rot; the work of the disease was so severe that there were no marketable grapes harvested on the unsprayed vines. Through a misunderstanding, the several plots were harvested without separating the yield. The plot receiving five sprays (Plot No. 1) showed only

a trace of black rot, whereas Plot No. 4, which received only "afterblossom" sprays, showed some loss from black rot. The full value of the preblossom sprays could only have been shown by taking the yields from each of the several plots. This unfortunately was not done.

Spraying versus Dusting in 1925

Demonstrations were arranged in the vineyard of Rev. Alfred Smith, of Wyoming, to compare the results of spraying with that of dusting. Accordingly, the following plots were laid out. Row No. 1, an outside row was left as a buffer row on which dust was applied; on Row No. 2, the first four vines were left undusted; the next eight vines were dusted according to the practice commonly recommended for dusting; the next eight vines were given a heavier dusting, nearly double the quantity used on the first eight vines; the remainder of the row was dusted according to the recommended practice for dusting. On Row No. 3, the first four vines were left unsprayed; the remainder of the row was given a Bordeaux Spray, a 3-5-50 formula, using an orchard power outfit equipped with a Boyce Double Spray Gun, in which the spray was directed down on the grape vines from above. (See Figure 12, page 34) With this method, a single spray application to the row, accomplished the most thorough covering that the writer has ever seen on grapes.

Five applications of sprays and dusts were made on the following dates:

1—Delayed dormant on April 20
2—Growth 5-8 inches on May 4
3—Preblossom spray on May 20
4—Afterblossom spray on June 10
5—"Size of peas" spray on June 22

For the dusting it may be said that it was not applied under what we consider the most ideal conditions for dust applications—that is during the dampness of evening, or the dew of early morning. Under such ideal conditions, the dust might have shown up even better. Also it may even be economical and really necessary to apply more applications of dust than of spray. The dust is applied much easier and more rapidly than the spray.

Evidence of "Carry-Over" Infection

On date of May 6, there was evidence of heavy infection on the untreated vines, which would become the "carry-over" source for the following season; most of this was the "dead arm" disease.

On May 20, some black rot was found on the fruit and leaves of the untreated vines. It was evident, on close inspection of the dusted vines, that more infection was found on the new canes than was present on the sprayed vines.

TABLE VI

Showing the Results of Spraying and Dusting at Rev. Alfred Smith's Vineyard in 1925

Treatment	Yield of Grapes on Acre Basis	Yield of Grapes in Tons on Acre Basis
Sprayed Plot	7327 lbs.	3.66 tons
Dusted Plot	6252 lbs.	3.12 tons
Unsprayed Plot	3025 lbs.	1.51 tons

The above data are very similar to those taken at Mr. N. W. Taylor's vineyard in 1924; there was very little black rot on the unsprayed plots and yet the sprayed and dusted plots gave considerable increases over the unsprayed; it seems probable that much of this increase in yield is brought about by the healthier and cleaner vines on the sprayed plots, due to checking the injury to vines from internodal infection (the so-called "carry-over" infection) which greatly weakens the vines. (See Figures 4 and 6)

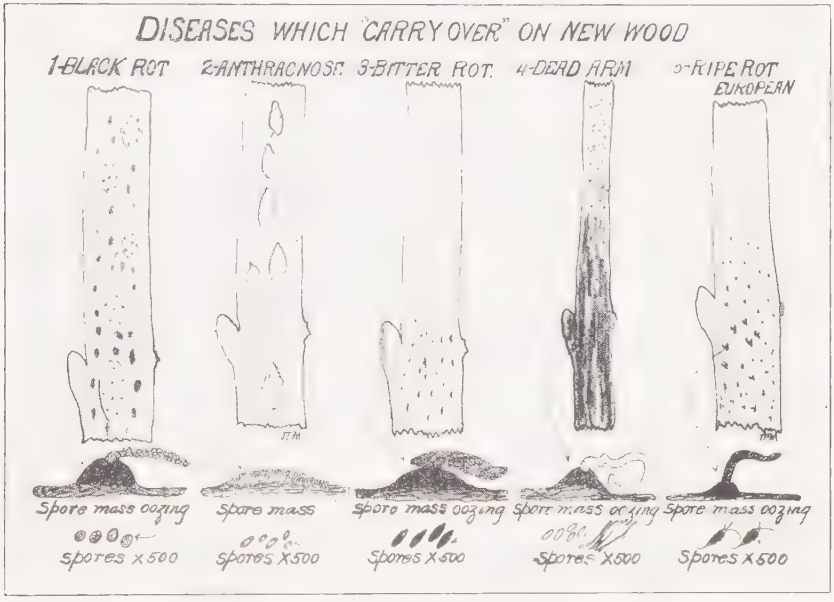

FIG. 6.—A diagrammatic drawing showing the nature of the "carry-over" infection of five different grape diseases which overwinter on the wood to be tied up. All five diseases are common in Delaware.
No. 1—is black rot, caused by the fungus *Guignardia Bidwellii.*
No. 2—is anthracnose, caused by the fungus *Sphaceloma ampelinum.*
No. 3—is bitter rot, caused by the fungus *Melanconium fuligineum.*
No. 4—is dead arm, caused by the fungus *Cryptosporella viticola.*
No. 5.—is ripe rot (European), caused by the fungus *Pestalozzia uvicola.*

The fruiting bodies of these fungi are shown below with the spores oozing; the spores more highly magnified are also shown.

Rev. Smith's vineyard was considerably weakened in 1924 by the "carry-over" infection, not only of the black rot but also by Reddick's so-called "dead arm" disease. This "carry-over" infection, as was shown in 1924, can only be prevented by applications of the delayed dormant spray and the one closely following the delayed dormant, that is, a spray within ten to twelve days.

GRAPE SPRAYING AND DUSTING DEMONSTRATIONS FOR 1926

In comparing spraying against dusting in the season of 1926, it was planned to give the dusting the advantage of favorable periods of application such as early morning, or late evening, when the absence of wind and presence of dew, or dampness, would favor dust sticking to the foliage.

The spraying vs. dusting work was again carried out in the vineyard of Rev. Alfred Smith, near Wyoming. The five spray program was carried out on the following dates:

1—The "Delayed Dormant" Spray May 3
2—The "Growth 6-8 Inch" Spray May 17
3—The "Preblossom" Spray June 7
4—The "Afterblossom" Spray June 16
5—The "Size of Peas" Spray June 28

The results of the spraying vs. dusting work are shown in Table VII. Rev. Smith this season (1926) used arsenate of lead (5 lbs. to 150 gallons) in the "preblossom" spray as well as the afterblossom spray. The result was almost complete control of the berry moth which was very severe on the checks. The sprayed plots averaged .39 tons more per acre than the dusted. This is in accord with the results of the previous season's work. The sprayed plot yielded 1.76 tons more than the unsprayed; this was 55% more than the yield of the unsprayed plot. Much of the injury to the unsprayed plot was the work of the berry moth. There was only a small amount of black rot.

TABLE VII

Grape Spraying and Dusting Demonstrations

Weights of Grapes from Plots in Vineyard of Rev. Alfred Smith and Son—Sept. 22, 1926

Block	Number of Vines	Total Weight of Grapes (pounds)	Yield per Vine (pounds)	Yield per Acre (tons)
1. Dusted	103	1160	11.26	4.54
2. Check	16	130	8.12	*3.17
3. Sprayed	103	1260	12.23	4.93
4. Check	16	130	8.12	*3.17

* Fruit on check (unsprayed) plot quite badly infested with berry moth.

1926 GRAPE SPRAYING WORK AT RALPH SPRUANCE'S VINEYARD AT SMYRNA

This season, the spraying work was located on Concord Grapes in the lowest area on Mr. Spruance's vineyard. The five spray program was compared with a four spray, a three, and a two spray program respectively, the object being to compare the early sprays against the late sprays; the two spray program was applied after blossoming had taken place. The season was very unusual, being very dry during the preblossom period, much like the season of 1923, only this season was much later. The "delayed dormant" spray was not applied till May 3, which is a week to 10 days later than average seasons. Careful observations indicated this season, that black rot dissemination, on account of the long drough, was delayed till after blossoming.

The result was, the early sprays, especially the preblossom spray, did not show the advantage this season over the late sprays, that is, the afterblossom sprays. Table VIII shows the results of spraying at Mr. Spruance's vineyard.

TABLE VIII

Weight of Grapes from Plot in Vineyard of Ralph E. Spruance—September 22, 1926

Block	Number of Vines	Total Weight of Grapes (pounds)	Yield per Vine (pounds)	Yield per Acre (tons)
1. 5 sprays	50	273.0	5.46	2.20
2. 4 sprays	48	262.5	5.46	2.20
3. 3 sprays	54	330.5	6.12	2.47
4. 2 sprays	16	90.5	5.65	2.28
5. Check (Unsprayed)	37	107.5	2.91	*1.07

* The fruit on the unsprayed plot was badly damaged by black rot; most of the grapes were not marketable.

Average yield per vine in sprayed blocks—5.67 lbs.
Average yield per vine in check block—2.91 lbs.
Average yield per acre in sprayed blocks—2.29 tons
Average yield per acre in check block—1.07 tons

The average yield of the sprayed plots was 2.29 tons per acre; the average yield of the unsprayed plot was 1.07 tons; the sprayed plots averaged 1.22 tons more than the unsprayed. There was an increase of over 114% for spraying.

1927 SPRAYING VERSUS DUSTING DEMONSTRATIONS AT THE VINEYARD OF REV. ALFRED SMITH NEAR WYOMING

This is the third year's work comparing spraying with dusting, using five applications, the "delayed dormant", the "6 to 8 inch" spray, the "preblossom", the "afterblossom" and the "size of peas" spray. Again the spraying showed a slight advantage over the dusting. The sprayed showed an increase of 62% over the unsprayed. Table VIII-A shows data for the year 1927.

TABLE VIII-A

Dusting Versus Spraying Demonstration at Vineyard of Rev. Alfred Smith

Block	Number of Vines	Weight of Grapes in Block	Estimated Yield per Acre in Tons
1—Check	60	285 lbs.	1.916
2—Sprayed	160	1230 lbs.	3.107
3—Dusted	168	1230 lbs.	2.954

TABLE IX

Showing Dates of Applying Sprays for the Seasons 1922 to 1927 Inclusive

Time of Spray	1922	1923	1924	1925	1926	1927
1 Delayed Dormant	April 26	April 24	May 6	April 22	May 3	April 28
2 Growth 6-8 Inches	May 9	May 8	May 15	May 6	May 17	May 17
3 Preblossom	May 23	May 22	May 27	May 27	June 7	June 8
4 Afterblossom	June 6	June 12	June 24	June 12	June 16	June 21
5 Size of Peas	June 23	June 26	July 5	June 22	June 28	July 5

Some Observations on Black Rot

It has been considered a very well established fact that the black rot fungus of grape can infect leaf growth only in the very young and tender stage (See Fig. 3). Careful experiments, by the writer, have substantiated this. Further careful experiments have shown that it is the preblossom sprays, particularly the one just preceding blossoming that is the greatest factor in most seasons in preventing black rot infection of the fruit; also it has been shown in these demonstrations that it is the delayed dormant spray, and the one closely following, that prevent, the "carry-over" infection on the new wood, that is on the part of the cane tied up the next spring. The following carefully garthered data given in Tables X and XI verify certain of the above statements and indicate over what period the dissemination of black rot spores from "carry-over" material may take place.

TABLE X

Showing the Position of the Leaf Infected with Black Rot, Giving the First Leaf Out Number "1", and Numbering Others Consecutively Thereafter.

Leaf Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Vine a		x											
" b								x	x				
" c				x	x			x					
" d			x										
" e		x											
" f				x									
" g					x								
" h								x					
" i				x	x			x	x				
" j							x	x					
" k	x*	x											
" l	x	x			x	x							
" m	x		x	x									
" n								x	x				
" o					x								
" p			x		x								
" q	x			x									
" r				x									
" s		x			x	x							
Totals	4	5	3	6	7	2	1	6	3	Total 37			

*(x) Indicates black rot infection on leaf numbered.

Table X shows that black rot begins dissemination with the susceptibility of the first leaf out and continues dissemination while the ninth leaf is still susceptible. The data shown in Table X were gathered June 22, 1925 at which time the grapes were the size of peas and the spraying program for black rot was over. A study of the totals at the bottom of Table X indicates that there were three periods of strong black rot dissemination, probably corresponding to the several rainy spells. The first period continued during the time when the first, second, and third leaves were susceptible, being most severe when the second leaf was susceptible; the next period, when leaves number four and five were susceptible, and the third period, when leaves number eight and nine were susceptible. This latter period corresponds to the blossoming period, when as soon as the blossom cap is removed, the young berry is most susceptible. This is the most dangerous period as far as infection of the fruit with black rot is concerned; this is the period when a covering of Bordeaux must precede blossoming if we are to be successful in the control of black rot on the fruit. Later sprays will not control infection which took place at this time.

In Table X black rot infections are recorded for thirty-seven leaves. Of this number, over 70% of the infections occur on the first five leaves,

showing how early black rot spores are disseminated; less than 30% of the infections fall on the sixth to the ninth leaves; none are recorded for the tenth leaf. The data shown in Table XI reverse the process of counting, that is, leaf number "One" is at the tip end, or growing point, and the leaves are counted from there consecutively.

TABLE XI

Showing the Position of the Leaf Infected With Black Rot When Leaf Number "1" is at the Growing Point and Others Numbered Consecutively.

Leaf Number	1	2	3	4	5	6	7	8	9	10	11	12	13	
Vine A								x	*x-					
" B							x		x		x-			
" C									x	x-				
" D							x	x	-					
" E										x-				
" F												x-		
" G							x			x	-			Very long vine
" H							x			-				Very long vine
" I													x-	
" J												x	x-	
" K								x			-			
" L							x			x		x-		
" M							x					x-		
Totals							6	3	3	4	1	4	2 =23	Total

* The dash(—) indicates number of leaves on the vine; for example, Vine A had 9 leaves; Vine B had 11 leaves, etc.

Table XI does not show the same data as is shown in Table X; it does, however, show that no infection was present on the first six leaves back from the growing tip on June 22, and the data in both tables would indicate that black rot dissemination is most active during the period when the first five leaves are susceptible. This period would include the growth from one inch to the close of blossoming.

The question might be asked, how long after leaf infection with black rot, before the spot is visible? Some experimental work done in 1924 and 1925 indicates that it is usually ten days; infection may take place only on very young and tender leaves.

When Does Fruit Infection With Black Rot Take Place?

Evidence presented by Galloway, (2) Selby, (3) and the writer (4) indicates that the spray immediately preceding the blossom, is the spray which, in most seasons, prevents the infection of grapes with the black rot fungus. The data taken in 1926 are an exception to this because the spring season was very dry until after the grapes had blossomed; practically no black rot dissemination had taken place until after blos-

soming. The preblossom spray is usually applied from one to two months before any severe rotting of the fruit takes place. The preblossom spray is usually applied the last week in May (See Table IX page 20) and black rot on the fruit may begin the first week in July, but is most active the last week in July, or the first week in August.

Since the afterblossom sprays have usually failed to control black rot, we must conclude that black rot infection takes place on the young fruit sometime during blossoming, and further we must admit that if infection takes place in the fruit during blossoming, then the black rot fungus which has infected the young and tender fruit, must penetrate deep enough so as not to be affected by the afterblossom sprays; it must also be admitted that the fungus is able to exist in a resting condition till the fruit has reached the proper physiological stage when black rot decay may take place.

This condition of affairs is exactly what our findings indicated in 1922, when the preblossom spray was unavoidably omitted. Very careful observations and examinations of the young grapes were made immediately after blossoming. The lenticels on the young grapes (beginning berries) showed evidence of disturbance which indicated black rot infection had taken place. Careful sectioning of these berries showed that black rot infection was present. Further evidence of the presence of such infection did not manifest itself till June 23. From then, until the first week in August, the presence of infection became more evident, and in spite of the grapes being kept covered with Bordeaux Spray during the entire period after blossoming, the crop was a failure on account of black rot.

Late spraying, under usual seasonal conditions in Delaware, is of no value for black rot control. In a number of cases, the writer has seen six, seven and eight afterblossom sprays applied on grapes for black rot, with the result, that 50% to 75% of the fruit rotted.

Can We Induce Black Rot of Grapes by Artificial Infection After the Fruit is Half Grown?

Reddick (5), in his experimental inoculation under field conditions, failed to bring about infection in grapes during two years of work, in which he made two thousand inoculations. He was working on grapes that were from one-half to two-thirds grown. Reddick's methods of inoculation were duplicated and similar results obtained, that is no infections took place.

It occurred to the writer that it was possible that we were not keeping the culsters in a moist atmosphere for a sufficient length of time to bring about infection. The writer had observed that at blossoming time, and immediately following, the lenticels (four or five in number) in the young grape berry are exceedingly large and wide open. These lenticels seem to almost disappear in the berry that is half grown. Is the closing of these lenticels the factor that keeps down infection during

the short periods of rainfall, or damp weather, in summer? Is it possible when the half grown cluster is kept in a moist atmosphere for a longer time, that infection may take place? To answer the above questions, the following experiments were planned in 1924: Black rotted berries were gathered July 7th, in the Dover district, and placed in moist chamber to mature the pycnospores and cause them to ooze out, so they could be used for inoculation work. On the date of July 14th, clusters of Concord grapes, attached to the vines at the writer's home vineyard near Newark, were tied in Mason fruit jars containing about one-half inch of water; one jar contained a cluster inoculated with black rot pycnospores and another jar a cluster that was not inoculated. Clusters that were not covered with jars were both inoculated and not inoculated as checks on the covered clusters. The tops of the jars were covered with waxed paper to keep the air about the clusters moist.

On July 26, the inoculated jar showed several berries rotting, and by August 14 two-thirds of the berries had rotted. The jar which was not inoculated had no rot. The cluster inoculated, but not covered, also had no rot.

Having met with success in producing black rot on grapes about two-thirds grown by artificial infection, by keeping the clusters in saturated atmosphere, the next question which arose was, can black rot be produced on grapes which were beginning to turn in color, providing they were kept under moist conditions similar to the above experiments?

Three different experiments were planned as follows with fruit attached to the vine:

Jar 1—Cluster thoroughly inoculated with black rot pycnospores from rotted fruit.
Jar 2—Not inoculated. (To learn if cluster carried infection.)
Jar 3—Cluster treated with copper carbonate, 4-4-50.

This work was carried out at four different vineyards on date of August 19 as follows:

A—At Massey's Vineyard, Smyrna, 3 jars.
B—At Buttery's Vineyard, Smyrna, 3 jars.
C—At Carter's Vineyard, Smyrna, 3 jars.
D—At Taylor's Vineyard, Dover, 3 jars as above on check plot.
E—At Taylor's Vineyard, Dover, 2 jars on clusters from full spraying program; one of the latter being inoculated with black rot and one not inoculated.

Final Notes Taken September 26 on Above Work:

At Massey's—Jar 1—Only one berry had black rot.
Jar 2—No rot
Jar 3—No rot

At Buttery's—Jar 1—No rot
Jar 2—Jar broken off, could not get data
Jar 3—Jar broken off, could not get data

At Carter's—Jar 1—50% of berries rotted with ripe rot (*Melanconium fuligineum*), —no black rot.
Jar 2—No black rot
Jar 3—No black rot

At Nat Taylor's—Jar 1—3 berries had black rot
Jar 2—No black rot
Jar 3—No black rot

At Nat Taylor's—on plot which had full spraying program
Jar 4—Inoculated, no black rot
Jar 5—Not inoculated, no black rot

The above data would indicate it is very difficult indeed to induce black rot on berries which are turning (that is ripening) even under a saturated atmosphere for five weeks. However, the inoculated cluster at Carter's showed that ripe rot, *Melanconium fuligineum* could readily induce rot under these conditions. This infection with ripe rot of course was unintentional; the fungus must have been present on the cluster selected for the experiment. Clusters not inoculated, but kept under a saturated condition, failed to show black rot infection.

1925 Experiments

To determine how many days a saturated atmosphere must be maintained to induce black rot on grapes from one-half to two-thirds grown, the following experiments were planned for 1925.

Clusters of fruit attached to the vine were placed in quart Mason fruit jars, the latter containing one-half inch of water; the jar was securely attached to the cane so as not to injure the cluster; the mouth of the jar was covered with wax paper. This soon brought about saturation of the air with moisture. Sufficient clusters were placed in jars so that some were kept covered from one to ten days. All were thoroughly inoculated with black rot pycnospores except the checks. The following results presented in table XII indicates that no infection took place in the open, that is in the clusters not covered; that clusters kept in saturated atmosphere for twenty-four hours or longer would take infection.

TABLE XII

Showing Results of Artificial Inoculation with Black Rot in 1925

Inoculation Made July 1	Treatment	Berries rotted 8/13	Berries not rotted 8/13	Percent rotted
1—Clusters not covered	Not inoculated	0	41	0
2—Clusters not covered	Thoroughly "	0	42	0
3—Cluster in jar 10 days	Not inoculated	0	38	0
4—Cluster in jar 1 day	Thoroughly "	18	27	40
5—Cluster in jar 2 days	" "	24	18	57.1
6—Cluster in jar 3 days	" "	25	10	71.4
7—Cluster in jar 5 days	" "	16	14	53.3
8—Cluster in jar 7 days	" "	25	5	83.3
9—Cluster in jar 10 days	" "	16	12	57.1

The above data would indicate that 24 hours of saturation afford sufficient time to induce 40% of the berries to take black rot infection; that longer time (from two to ten days) gives more thorough infection, rotting from 50% to 83% of the berries. Clusters not kept in saturated atmosphere did not take black rot.

It is the opinion of the writer that Reddick's failures to induce infection on grapes about one-half to two-thirds grown, from artificial inoculations, were due to his failure to maintain sufficient moisture about the cluster. Natural infection, which he supposed was from inoculation when grapes were about half grown, most probably had taken place at blossoming time.

Our observations would indicate that spore dissemination from winter "carry-over" sources takes place during spring rains, from about the last week in April to the last week in June, under Delaware conditions. This is the period from beginning growth until directly after blossoming.

Dissemination of spores (pycnospores) produced on the leaves and fruit, during the season of growth seldom takes place earlier than the first week in July, and then only sparingly, as the fruiting bodies (pycnidia) of the fungus of black rot are not mature. At this time of the year, we seldom have periods of saturated atmosphere long enough to bring about infection on the fruit with black rot. As a factor in bringing about fruit infection, the writer has not been able to establish any connection whatsoever with the newly formed black rot pycnospores All evidence points back to the dissemination from the "carry-over" on the vine tied up.

Hesler and Whetzel in their textbook, Manual of Fruit Diseases, p. 231, state, "In North Carolina the heavy losses come within a week after blossoming time, while in New York the greatest injury is incurred when the berry is one-half to two-thirds grown."

In Delaware, the author has observed considerable shattering of clusters, following infection on cluster parts at blossoming time.

Other Grape Diseases Serious in Delaware

In making a study of the "carry-over" of black rot on the new wood to be tied up, it was learned that there were several important diseases that carried over in the same way as black rot, that is, on the first four or five internodes of the new canes. This of course is the wood that will be tied up to bear the next season's crop. To determine the causal fungus of these several diseases, there was brought into the laboratory, during the months of February and March of 1923, 1924, and 1925, new wood showing several different kinds of infections or lesions on the internodes. The nature of these lesions varied in size from very conspicuous large spots of one-sixteenth inch to one-half inch in length and of nearly the same width, to very small specks, similar to what is known as "pepper and salt" disease. A careful study of these infections showed not only black rot (*Guignardia Bidwellii*) carrying over on the canes, but also Anthracnose (*Gleocsporium ampelophagum—Sphaceloma ampelinum*), dead arm (*Cryptosporella viticola*) and a fungus known as *Pestalozzia uvicola* which seldom produces a fruit rot on our American varieties as it does on the European varieties, yet it does produce specking on the canes particularly in the region of the buds and nodes.

The nature of the "carry-over" of these diseases is shown in Fig. 6, page 17.

The Dead Arm Disease is Severe

Vineyards that have been poorly fed and have not been sprayed early, have suffered severely from the dead arm disease. Under Delaware conditions, the most severe injury from this disease is the weakened vines due to heavy infection of the new growth, especially the first two or three internodes; sometimes the disease is so severe as to blacken the bark or cambium for some distance along the new growth (See Fig. 6 No. 4, page 17). This blackening and injury of the new canes greatly weakens the new growth. As a result, many times there are few canes to tie up and these are very brittle and easily broken off when tying, or by the wind after tying.

This fungus winters over in the blackened areas. The mature fruiting body is shown with spores oozing out in a gelatinous mass in the lower part of Fig. 6, No. 4. The summer spores highly magnified are shown below in the same figure. These spores are of two kinds, those that are short, oval and hyaline and others that are lone, threadlike, and also hyaline. There may also be a winter spore found in a similar fruiting body. Spore dissemination takes place as soon as the buds break; infection of the new wood takes place before the growth is two to three inches out. *For thorough control, the delayed dormant spray must be given,* using Bordeaux spray when the growth is one-half to three-fourths inches out.

There has not been much dying of large arms from this disease in Delaware, but older vineyards which have not been properly sprayed or

fertilized have shown some dying of old wood. This disease, like black rot, is spread by infected nursery stock. *The use of infected trimmings for nursery stock should not be practiced by growers, nor should nursery men be permitted to use the same, as black rot, dead arm, anthracnose, ripe rot, and bitter rot are spread wholesale in this manner.*

FIG. 7.—Showing anthracnose lesions on the new growth. These lesions become the "carry-over" for next season's infection. (Photograph by Arthur S. Rhoads, Bul. 178, Fla. Exp. Sta.)

Anthracnose or "Bird's Eye" Rot

This disease caused by the fungus *Sphaceloma ampelinum* has often been confused with black rot. It would probably be more proper to say that growers often apply the name "Bird's Eye" rot to one of the

rapid rot stages of Black rot. Generally this anthracnose is not serious on the Concord or Moore's Early varieties; it does cause lesions, or spots, on the vine more irregular and somewhat more sunken than the spots made by the black rot fungus. (See Fig. 7, page 28). Sometimes it causes a quick rot of grapes, but well sprayed vineyards, especially those given the early sprays do not suffer loss in Delaware. The nature of the spore mass and the form of the spores are shown in the lower part of No. 2 in Fig. 6.

Ripe Rot

This disease caused by the fungus *Glomerella cingulata* has only once been observed to be severe in this state on the Concord variety; it appeared in a vineyard poorly sprayed, following several days of heavy fog when grapes were turning. The fact that it does not appear in vineyards properly sprayed that is, with early sprays, leads the writer to conclude that it carries over on the new wood similar to the other diseases. Growers often give the name ripe rot to black rot.

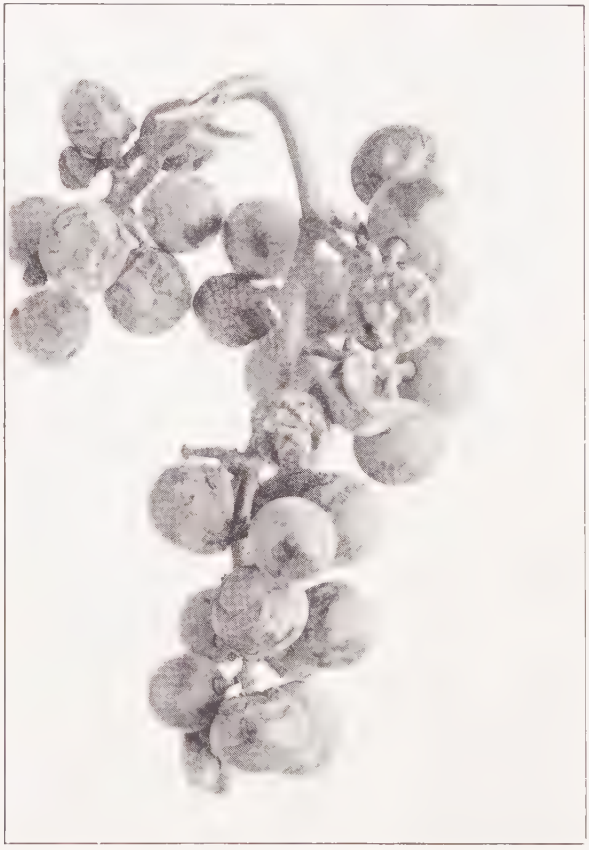

FIG. 8.—Showing the early stages of bitter rot, a disease not common on the Concord or Moore's Early varieties, but sometimes quite severe on Agawam. It is caused by the fungus *Melanconium fuligineum,* which carries over, on the infected vines, similar to the several other grape diseases.

Bitter Rot

Bitter rot is quite similar to ripe rot in appearance; it does not, however, affect the berries of Concord or Moore's Early as it does the European varieties. It is often severe on the variety Agawam. It is caused by the fungus *Melanconium fuligineum* (See Fig. 8, page 30).

Downy Mildew

Downey Mildew, in poorly sprayed vineyards, is sometimes quite serious on the foliage in the late summer; it seldom affects the clusters of the varieties Concord or Moore's Early in Delaware. It may attack all the tender growing parts of the vine or the cluster, (See Fig. 10, page 32) but usually it is found on the foliage producing greenish, yellow, irregular areas, or spots, on the upper surface (See Fig. 9, below). These spots later die and turn reddish brown; on the under surface, the loose, white, downy growth of the fungus may be seen. The summer spores are produced abundantly in the white downy growth; the winter spore, or resting stage, may occur on the foliage, but is not common in Delaware. The causal fungus is known as *Plasmopora viticola.*

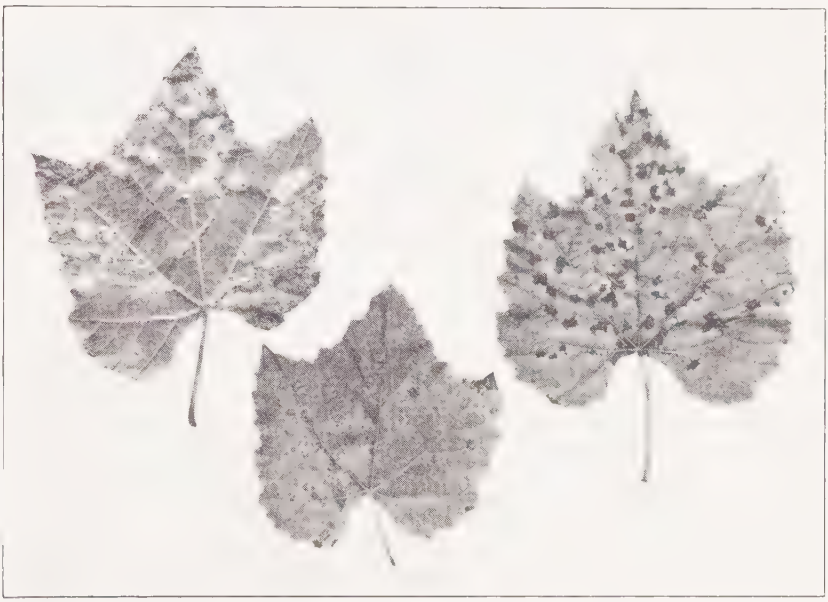

FIG. 9.—Showing the downy mildew on the leaves of grape. This disease attacks all our varieties, but in well sprayed vineyards, it is readily controlled. It differs from the other diseases which are mainly spread by water, this disease is spread by wind. (Photograph by Arthur S. Rhoads, Bul. 178, Fla. Exp. Sta.)

FIG. 10.—Fruit infection of the young grape clusters by downy mildew. (Photograph by courtesy of the Department of Plant Pathology of Cornell University.)

Other Diseases That Are Not Serious

The *powdery mildew* (*Unicinula necator*) has been observed in this State, but it never has been serious enough to be considered of economic importance. The early attack is characterized by fine white snowlike masses of the fungus growth. Berries, affected, finally take on a gray appearance and fail to mature.

Crown Gall, a bacterial disease, may cause root and stem troubles (See Fig. 11) which may greatly weaken the plant. The disease is seldom severe in this State. Nursery Stock should however be carefully examined and all gall infected roots thrown out.

Other root troubles may develop such as the rot caused by the fungus *Ozonium omnivorum.* Thus far, it has not been observed in the State.

FIG. 11.—Showing crown gall, a bacterial disease which causes galls, or irregular growths, on the vines. Occasionally it causes root trouble, but it is not severe in Delaware. Avoid infected nursery stock.

An Efficient Spraying Practice is Required

In the control of grape diseases and insects, it is very important that a thorough and timely spraying practice be carried out. This not only includes efficient spraying machinery with pumps that will maintain and deliver the spray at from 150 to 275 lbs. pressure, but the arms and nozzles must be adjusted, or manipulated, so that the spray hits the vines, leaves and clusters to be covered. Timeliness of the application is exceedingly important; a failure to get on the delayed dormant spray when the new growth is from one-half to three-fourths of an inch out means, "carry-over" infection takes place, which is the source of infection for next season's crop; a failure to get on the preblossom spray with an arsenical means, in the average season, both black rot and berry moth in spite of thorough later spraying.

FIG. 12.—Using the orchard power sprayer, drawn with tractor, in the vineyard. With the Boyce double spray gun, this method of spraying grapes is very rapid and efficient; nozzle trouble is overcome and wind does not interfere, as one may always use the protected side of the sprayer. (Photograph by County Agent R. E. Wilson.)

With an orchard spraying outfit equipped with a spray gun, thorough spraying is easily done for the first three or four sprays (See Fig. 12, above), as the operator may direct the spray downward over all parts of the vine and the new growth. This is not so easily done after the growth becomes heavy. With such an outfit, wind does not interfere because the operator may always spray on the side protected by the sprayer, and both he, and the driver, are free from blowing spray material. With the traction outfits, very often the wind makes it impos-

sible to cover the vines on one side and the discomfort from the spray covering the operator and the team, makes it necessary to stop work; for this reason, very often, the most important spraying periods are missed. In demonstration work in the State, using five applications, dusting has not quite equalled spraying; more applications of dust may have equalled the spraying. Some Delaware growers have had success with dust on grapes.

Cultural Practices Help Control Disease

To insure control of grape diseases, prune out, before the spring growth begins, all mummied fruit, canker, dead wood, and excess of vine growth, and burn. Tie up firmly and space well; proper spacing helps greatly in the ventilation of the vine and fruit.

It is quite advisable before growth starts, to plow under all diseased fruit and leaves on the ground; this practice prevents all possible spread of disease and insects from such sources.

Sprays for Grapes

Under Delaware conditions, no scale, or other injurious insects, overwinter on the canes, and in place of the usual dormant lime-sulphur spray, a delayed dormant spray of Bordeaux, (See Spray Calendar page 36) a 6-6-50 formula is used; this should be applied when the new growth is just pushing out from one-half to three-fourths inch.

Lime sulphur should not be used as a summer spray for grapes, as it injures the foliage.

For the late spring, or summer, sprays, a 4-4-50 Bordeaux should be used in traction outfits working under pressure of 150 to 200 lbs. Large orchard power outfits, working under pressure of 250 to 350 lbs. and using large spray guns should use a 3-5-50 Bodeaux. Arsenate of lead, nicotine sulphate and other ingredients for insects may be combined with Bordeaux.

Colorless Mixtures for Late Sprays

Bordeaux mixture when applied on ripening fruit leaves a heavy covering of spray that is very objectionable and that often reduces the market value of the grapes. For ripening grapes colorless copper sprays have been used. The more common colorless sprays are soda Bordeaux, ammonical copper carbonate, and neutral, or basic, copper acetate; this latter material is coming into general use because of its convenience; it is ready for use when added to water. For convenience the several formulas are given. In making soda Bordeaux, care should be taken to have the mixture alkaline, that is a slight excess of the soda should be used.

Soda Bordeaux, Weak Mixture

Copper sulfate	2 lbs.
Caustic Soda about	¾ lb.
Water	50 gallons

Ammonical Copper Carbonate

Copper carbonate	6 oz.
Ammonia, about	3 pints
Water	50 gallons

Neutral, Or Basic, Copper Acetate

Copper acetate (preferably basic)	2 lbs.
Water	50 gallons

GRAPE SPRAYING PROGRAM FOR DELAWARE

Time	Purpose	Material
1 *"The Delayed Dormant."* When the new growth is one-half to three-fourths inches out apply the delayed dormant spray.	To prevent infections on the new growth of black rot, anthracnose bitter rot, dead arm and ripe rot. Infection at this time becomes the "carry-over" for next season's fungous diseases.	Bordeaux mixture 6-6-50; that is 6 lbs. of copper sulphate, 6 lbs. of hydrate lime and 50 gallons of water.
2 *"5 to 8 inch Spray."* When the new shoots are 5 to 8 inches long.	To prevent "carry-over" and cluster infection.	Bordeaux mixtures 3-5-50 for outfits using spray guns; 4-4-50 for traction outfits.
3—*"The Preblossom Spray."* Just as close to blossoming as possible 5 to 10% of the blossoms may be out.	The most important spray to prevent black rot of the fruit; it controls the first brood of berry moth; for all fungus and insect troubles.	Bordeaux mixtures 3-5-50 and 1½ lbs. of powdered arsenate of lead. If leaf hopper is present use ½ pint of 40% nicotine sulphate.
4—*"Afterblossom Spray."* This spray should be applied right after blossoming.	A very important spray for black rot, anthracnose; also berry moth, rose chafer, and leaf hopper.	Same material as in the preblossom spray. If rose bug is plentiful add one pint of cheap molasses.
5 *"Size of Peas Spray."* When the berries are size of peas or begin to touch in the cluster—about two weeks after the previous spray.	To control all fungous diseases and all insect troubles, including the root worm.	Same material as in the preblossom spray.
6—A late spray may be applied as the fruit begins to ripen.	For ripe rots and mildews.	Use colorless sprays as Soda Bordeaux, ammoniacal copper carbonate or neutral copper acetate.

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